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Numerical study on multi-fracture propagation geometries in multiple fracture treatments: the effects of stress shadow

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When multiple fractures are created in a horizontal well, the effects of stress shadow or stress interference become an important consideration. Fracture spacing, fracture width distributions and propagation paths are all associated with stress shadow effects. Consequently, to make rational decisions on completion strategies and production performance analysis, operators need to make clear the stress shadow effects among multi-fractures.

In this paper, a multi-fracture propagation model was established to study the effects of stress shadow numerically. In the model, the stress field of multiple fractures was calculated by pseudo 3D boundary element method. Fluid flow was described by the lubrication equation. Fracture propagation velocities and paths were explicitly determined by subcritical fracture propagation law and maximum energy release rate law respectively. Multiple fractures propagation paths under different fracturing modes, such as consecutive fracturing and simultaneous fracturing in one well or pad, were investigated by this model. The results show that uneven fracture geometries can be the result of stress shadow, which limits the fracture cluster number in one stage operation. Nonuniform fracturing spacing may aggravate the nonplanar propagation trajectories for simultaneous growth due to unequal induced stresses among each fracture. Changing fracturing sequences in multiple-well fracturing can minimize the effect of stress shadow. Operators should pay more attention on fracture spacing distributions and fracture sequences to make rational decisions on completions strategies and production performance analysis.